Publication number : 2001-264782

Date of publication of application : 26.09.2001

Int.Cl. G02F 1/1341 G02F 1/1339 G09F 9/00

Application number : 2000-073643

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Date of filing : 16.03.2000

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METHOD OF FILLING GAP OF FLAT PANEL SUBSTRATE WITH VISCOUS LIQUID MATERIAL

[Abstract]

PROBLEM TO BE SOLVED: To provide a method of filling the gap between flat panel substrates with a viscous liquid material by which a material such as a liquid crystal in a specified amount can be efficiently supplied in a short time instead of injecting a viscous liquid material such as a liquid crystal to a narrow gap between two substrates which requires a long time.

SOLUTION: A viscous liquid material of a specified amount can be efficiently supplied in a short time in the following processes. The method includes a

process of supplying the viscous liquid material by 50 to 95% of the whole amount to be supplied to the inside of a sealing agent layer 4 formed in the periphery on a lower substrate 2 with an injection port formed on the end face of the substrate, a process of positioning and laminating an upper substrate 3 on the lower substrate 2 and fixing to obtain a substrate 1, a process of injecting the rest of the viscous liquid material by 5 to 50% of the whole amount through the injection port 5 of the substrate 1, and a process of sealing the injection port 5.

[Claim(s)]

[Claim 1] A method for filling gap of flat panel substrates with viscous liquid material, the method comprising the steps of;

forming sealing materials at an injection port formed at an edge of a periphery of one of the flat panel substrates;

supplying most of a filling required amount of the viscous liquid materials to an inside of a substrate enclosed by the sealing materials;

overlapping and adhering an opposed substrate on the substrate to which the viscous liquid materials have been supplied with a spacer therebetween if necessary;

supplying remaining viscous liquid materials into an injection port formed at an edge of the adhered substrate under a reduced pressure and filling a gap between the substrates with viscous liquid materials by returning a current state to atmospheric pressure or greater; and

sealing the injection port.

[Claim 2] A method for filling gap of flat panel substrates with viscous liquid material, the method comprising the steps of;

forming sealing materials at an injection port formed at an edge of a periphery of one of the flat panel substrates;

supplying most of a filling required amount of the viscous liquid materials to an inside of a substrate enclosed by the sealing materials under a reduced pressure;

overlapping and adhering an opposed substrate under the reduced pressure on the substrate to which the viscous liquid materials have been supplied with a spacer therebetween if necessary;

supplying remaining viscous liquid materials into an injection port formed at an edge of the adhered substrate under a reduced pressured and filling a gap between the substrates with viscous liquid materials by returning a current state to atmospheric pressure or greater; and

sealing the injection port.

[Claim 3] The method according to claim 1 or 2, wherein 50 through 95 % of the required amount of the viscous liquid materials is supplied to an inside of a substrate enclosed by the sealing materials

[Claim 4] The method according to any one of claims 1 to 3, wherein the viscous liquid materials are supplied into an inside of the substrate enclosed

by the sealing materials to have a shape similar to a sealing material shape.

[Claim 5] The method according to any one of claims 1 to 4, wherein the sealing materials formed at an injection port formed at an edge of a periphery of one of the flat panel substrates is previously hardened before most of the filling required amount of the viscous liquid materials is supplied to an inside of a substrate enclosed by the sealing materials; and when an opposed substrate is overlapped and adhered on the substrate under the pressure reduction to which the viscous liquid materials has been supplied with a spacer between if necessary, a main hardening is performed.

[Claim 6] The method according to any one of claims 1 to 5, wherein the substrate is a transparent substrate that is composed of a glass or a plastic material having a required function layer such as a transparent electrode or an orientation film.

[Claim 7] The method according to any one of claims 1 to 5, wherein the viscous liquid materials are function materials for a flat panel such as a liquid crystal or electrochromical material, and the supplying step is performed by a drop method or a coating method.

[Title of the Invention]

METHOD FOR FILLING GAP OF FLAT PANEL SUBSTRATES WITH VISCOUS LIQUID MATERIAL

[Detailed Description of the Invention]

[Field of the Invention]

The present invetion relates to a method for filling a gap of a flat panel substrate with a viscous liquid material, more particularly to a method for filling a liquid crystal in which the gap is formed as below a few micro-meters.

[Description of the Prior Art]

In the conventional art, as a typical flat panel, there is a liquid crystal display device that a material at mucus is filled with between a flat panel substrate. In the liquid crystal display device, there is a liquid crystal injection method filling with a liquid crystal the gap between a substrate formed as below few micro-meters as depicted in R> 3(a) of FIG. 3, wherein in the liquid crystal injection method, an upper substrate 33 is connected with a sealing material 34 which an injection port 35 is built in an outer circle of an under substrate 32 and so the upper substrate 33 is connected through the injection port 35 and a liquid crystal cell 31 having a liquid crystal injection

unit 36 is surrounded with a sealing material 34. Subsequently, a liquid crystal container 42, in which a liquid crystal 41 is formed inside the liquid crystal cell 31, is arranged inside a vacuum chamber 30 and the vacuum chamber 30 is decompressed and then an exhaust gas inside the liquid crystal cell 31 and the liquid crystal 41is deaerated. Also, as depicted in FIG. 3(b), a base 44, in which the liquid crystal container 42 is arranged, is lifted by a lifter 45, the liquid crystal 41 is connected with the injection port 35 and then the vacuum chamber 30 is returned as a atmospheric pressure state. And also, a liquid crystal is injected inside the liquid crystal injection unit 36 by a pressure difference between an inside of a cell and the vacuum chamber 30 and then the liquid crystal cell 31 is obtained by a seal of the liquid crystal injection unit 36

However, if an increase of a liquid crystal cell size and a diminution of a cell gap are requested because an applied field of liquid crystal is enlarged, there is a problem needs a considerable time according to a liquid crystal injection. In the event that a liquid crystal having a high viscosity is used, the injection time is doubled and thus a productivity enhancement in a manufacture of a liquid crystal is reduced. Accordingly, a solution of the problem is highly requested. Also, in order that a peripheral part of an injection port of a liquid crystal cell is connected with the liquid crystal, a

liquid crystal greater than the titer is requested and a material loss and a contamination of a liquid crystal is generated.

A method compressing a vacuum inner part injecting a liquid crystal is suggested as one method solving the above-mentioned problem, but they are quite expensive and a treatment problem is generated because a large vacuum container is highly comressed.

A driping method of a liquid crystal for solving the injection time in the liquid crystal injection method is suggested and is substantially used, wherein, in the method, a predetermined liquid crystal inside an under substrate is exactly weighed and dripped and then a long-running injection time doesn't need and obtain a liquid crystal display device by jointing an upper substrate and hardening the a sealing material 34.

[Problems to be Solved by the Invention]

In the driping method, a liquid crystal dripped the under substrate has to be equally unfolded inner side when the upper substrate is pressed at the under substrate. However, the liquid crystal is attached to a real surface, an adhesive plate is impaired, the liquid crystal is discharged, an adhesion to a real substrate is unsatisfied and then it is difficulty to obtain a gap accuracy. Accordingly, there were problems that a techinc and an apparatus for

enhancing a weighing accuracy and a dripping accuracy is requested and a management technic and facilities in a production is complicatied in order to control a requested volume of a liquid crystal.

It is an object of the present invention is to provide a method sovlving the problem in the driping method, wherein in the method, a material at mucus is able to filled between a huge and narrow substrates or in case of obtaining an electro-chromic display device, a liquid crystal is fillied in a huge liquid crystal panel and a minute liquid crystal cell at a short time, an electro-chromic materials besides a liquid crystal is able to be filled with.

[Means for Solving the Problem]

A method for filling gap of flat panel substrates with viscous liquid material described in claim 1 of the present invention, comprises the steps of; forming sealing materials at an injection port formed at an edge of a periphery of one of the flat panel substrates; supplying most of filling required amount of the viscous liquid materials to an inside of a substrate enclosed by the sealing materials; overlapping and adhering an opposed substrate on the substrate to which the viscous liquid materials has been supplied with a spacer between if necessary; supplying remaining viscous liquid materials into an injection port formed at an edge of the adhered

substrate under a pressured reduction and filling a gap between the substrates with viscous liquid materials by returning a current state to an atmosphere pressure or the greater; and sealing the injection port.

According to an invention of claim 1, before a liquid crystal is obtained by combining two substrates with each other, most of filling required amount of the liquid crystal calculated according to a size of the substrate is supplied at an inner side of a sealing material formed at a periphery of one side substrate by dropping the liquid crystal using a drop device such as a dispenser or coating it by a blade method. After the sealing is hardened by combining the two substrates with each other, remaining liquid crystal is injected and filled at a remained space through the injection port. That is, the total required amount of the liquid crystal is divided into two parts and supplying operations of twice are performed.

In the drop method of the liquid crystal. As the conventional method, when the total required amount of the liquid crystal is supplied once, a precise weighting of the total required amount, an uniform drop device, and a control of the process are required. When the lower and upper substrates are combined with each other after a supply of the liquid crystal, a complex process control and apparatus are required in order to prevent the liquid

crystal from being overflown from the sealing material, to prevent a bubble due to a lack of the liquid crystal from being occurred, and to produce uniform gap. However, the present invention performs a drop supply of the liquid crystal twice as described above. During a combination of the substrates, a drop amount of a first liquid crystal as much as possible is supplied within the limit that the sealing materials are not contact with each other. Since the first drop amount is not a total required amount, it does not occur the problems of the conventional method. It is unnecessary to consider a range of a supplying amount. When two substrates are combined with each other, is easy to calculate a size of a gap. This causes a liquid crystal substrate having a stable performance to be made. Next, a liquid crystal is injected and filled at a remaining pore of an edge of a sealing material formed by the combination of the substrates by the conventional injection method. Accordingly, a precise weighting and a control of amount of the liquid crystal are not needed, and filling of the liquid crystal is easily performed within a short time.

A method for filling gap of flat panel substrates with viscous liquid material described in claim 2, comprises the steps of; forming sealing materials at an injection port formed at an edge of a periphery of one of the flat panel substrates; supplying most of filling required amount of the

viscous liquid materials to an inside of a substrate enclosed by the sealing materials under a pressure reduction; overlapping and adhering an opposed substrate under the pressure reduction on the substrate to which the viscous liquid materials has been supplied with a spacer between if necessary; supplying remaining viscous liquid materials into an injection port formed at an edge of the adhered substrate under a pressured reduction and filling a gap between the substrates with viscous liquid materials by returning a current state to an atmosphere pressure or the greater; and sealing the injection port.

An injection port is formed at a periphery of an edge of one side substrate. After a formation of the sealing material, all following procedures are performed under a clean atmosphere of a pressure reduction. In addition to effects of claim1, a substrate of a high quality and yield is efficiently made.

In the method described a claim according to claim 1 or 2, wherein 50 through 95 % of required amount of the viscous liquid materials is supplied to an inside of a substrate enclosed by the sealing materials. During a combination of the substrates, a drop amount of a first liquid crystal as much as possible is supplied within the limit that the liquid crystal does not contact with the sealing material. This causes a remaining pore area to be reduced,

and to an injecting time from a next injection port to be shortened. An uniform spreading optimal value of the liquid crystal Amount of a first filled liquid crystal is selected as according to a filled shape and method. A liquid crystal of 50 to 95 % is preferable. The mount of the liquid crystal is unnecessary to be precisely weighted and controlled. The operation is easy and efficient.

An invention according to claim 4 has the viscous liquid materials supplied into an inside of the substrate enclosed by the sealing materials to have a shape similar to a sealing material shape. When an opposed substrate is overlapped with the lower substrate, viscous liquid materials having uniform thickness are spread into the substrate enclosed by the sealing material. The liquid crystal does not contact with a non-hardening sealing material and does not overflow the sealing material. amount of a liquid crystal as much as possible can be put. At this time, an optimal shape can be obtained by a control of a drop amount and a location using a dispenser and a control of a coating surface according to a blade method.

In A method described in claim 5 according to any one of claims 1 to 4, the sealing materials formed at an injection port formed at an edge of a periphery of one of the flat panel substrates is previously hardened before

most of filling required amount of the viscous liquid materials is supplied to an inside of a substrate enclosed by the sealing materials; and when an opposed substrate is overlapped and adhered on the substrate under the pressure reduction to which the viscous liquid materials has been supplied with a spacer between if necessary, a main hardening is performed. When the opposed substrate is overlapped and adhered on the lower substrate, although viscous liquid materials spread in the substrate contact with the sealing material, the previous hardening prevents properties and adhesive property of the liquid crystal from being deteriorated.

In A method described in claim 6 according to any one of claims 1 to 5, the substrate is a transparent substrate that is composed of a glass or a plastic material having a required function layer such as a transparent electrode or an orientation film.

The method according to any one of claims 1 to 5, wherein the viscous liquid materials are function materials for a flat panel such as a liquid crystal or electrochromical material, and the supplying step is performed by a drop method or a coating method.

[Embodiment of the Invention]

Hereinafter, an embodiment of a liquid crystal filling method in a

method for filling gap of flat panel substrates with viscous liquid material according to the present invention will be described with reference to the accompanying drawings. FIGS. 1(a) through 1(f) are views for illustrating a process sequence in a liquid crystal injecting method according to the present invention. First, as shown in FIG. 1(a), a sealing material 4 is formed at a periphery of a surface of one side substrate (referred to as 'lower substrate') 2 using ultraviolet rays hardening resin, ultraviolet rays hardening resin, or thermosetting combined resin. At least one liquid crystal injection port 5 is formed at an edge of the lower substrate 2. The sealing material 4 is formed at the liquid crystal injection port 5. Next, a liquid crystal of 50 through 95 % of required amount for filling a liquid crystal cell calculated with respect to a size of the lower substrate 2 is dropped using a drop device such as a dispenser as shown in FIG. 1(b) or 1(b') to the lower substrate 2 in which the sealing material 4 and the liquid crystal injection port 5 are installed, in a vacuum chamber under an atmosphere pressure or a pressure reduction of 10^{-3} torr. FIG. 1(b) shows an example of a case that a plurality of liquid crystals 7 are dropped at an inside of the lower substrate 2 enclosed by the sealing material 4 at the same intervals. FIG. 1(b') shows an exampled of a case that the lower substrate 2 is coated in the similar manner in the sealing material 4. The drop of the liquid crystal is not limited to the shown

embodiment. However, the liquid crystals may be concentrated and dropped in the vicinity of a center of an inside of the lower substrate 2 enclosed by the sealing material 4.

As described previously, when a liquid crystal of 50 through 95 % of required amount is dropped, as shown in FIG. 1(c) and FIG. 1(d), an opposed substrate (referred to as 'upper substrate' hereinafter) is combined with the lower substrate 2 under a pressure reduction of 10^{-3} torr. In the combination, a pressure plate 9 is loaded on the upper substrate 3 aligned and mounted on the lower substrate 2, while applying a load of 10 kg/m^2 thereto, an ultraviolet lamp 10 semi-hardens a hardening resin of the sealing material 4 from a lower portion of the lower substrate 2, thereby pressurizing the lower substrate 2 and the upper substrate 3. Thereafter, as shown in FIG. 1(e), the pressurized lower substrate 2 and upper substrate 3 are positioned on a heating plate 12 having a heater 13 therein, and heated at 100 through 140 °C for 2 through 3 minutes. This causes the hardening resin to be hardened to combine the upper substrate 3 with the lower substrate 2, and a liquid crystal substrate 1 of sealing a liquid crystal of 50 through 95 % of required amount is obtained.

Thereafter, after the combined substrate 1 is put in the same vacuum

chamber under a pressure reduction of 10^{-3} torr, as shown in FIG. 1(f), for example, using a liquid crystal drop device 6 such as a dispenser, a remaining liquid crystal of 5 through 50 % required to fill a remained pore is dropped at an injection port 5 formed at an edge of the lower substrate 2. The liquid crystal substrate is put under an atmosphere pressure or a pressurized state. Accordingly, the liquid crystal dropped at the injection port 5 is injected and filled at a remained pore of the liquid crystal substrate 1.

According to a method of the present invention, as described above, when the lower substrate 2 and the upper substrate 3 in which the liquid crystal is supplied to an inside of the sealing material are located, and the lower and upper substrates 2 and 3 are heated and combined by a hardening of the sealing material, a liquid crystal is limited to 50 through 95 % of required amount, thereby preventing a pressed and spread liquid crystal from being adhered to a surface of the sealing material or being flown. Furthermore, this causes an adhesive force of the sealing material to the substrate to be reduced, thereby preventing seal loss. In addition, a plurality of drops due to a weighting of a high precision in a prior art are unnecessary, thereby solving a problem of disturbing much practice use in the conventional liquid crystal drop method.

Next, as one example of methods for efficiently filling a liquid crystal based on a method of the present invention, a liquid crystal drop method of performing one by one will be described. FIG. 2 is a schematic view for showing an example of an apparatus that supplies the liquid crystals one by one to perform a liquid crystal filling method. In the supply apparatus, a substrate introduction chamber B, a liquid crystal supply chamber C, a location set chamber D, a combination/ultraviolet rays hardening chamber E, and a heating chamber F are radially arranged around a substrate conveying chamber A to communicate with each other with the substrate conveying chamber A and gate valves 20B through 20F between.

A conveying robot 15 is arranged in the substrate conveying chamber A, and conveys substrates to respective chambers through the substrate conveying chamber A. In the liquid crystal supply chamber C, a liquid crystal is supplied to the conveyed lower substrate 2. For example, a drop device 6 such as a dispenser and an X-Y movable table 17 are installed at the liquid crystal supply chamber C. The X-Y movable table 17 is a table for moving the lower substrate 2 in order to drop the liquid crystal 7 to a plurality of parts as shown in FIG. 1(b) when a liquid crystal 7 is dropped from a drop device 6 to an inside of the lower substrate 2 enclosed by the sealing material 4,

Moreover, an alignment table 22 is arranged at the location set chamber D. A sensor camera is not shown in drawings but is arranged at an outside of the location set chamber D as a detector. Locations of the lower substrate 2 and the upper substrate3 to which a liquid crystal is dropped and supplied are set, so that the lower substrate 2 and the upper substrate 3 are exactly combined with each other. A pressure plate 9 supported by an outdoor elevator 26 is arranged at an upper portion of the combination/ultraviolet rays hardening chamber E, a window 24 is installed at a lower portion of the combination/ultraviolet rays hardening chamber E. Ultraviolet rays from an outdoor ultraviolet lamp 10 is irradiated to the window 24. A heating plate 12 having a heater 13 therein is installed at the heating chamber F.

A procedure for filling a liquid crystal using an apparatus having the construction mentioned above will now be explained. Firstly, among two substrates of required size forming a liquid crystal substrate, a sealing material 4 is formed at a periphery of one surface of the lower substrate 2 by a hardening resin disposed at an injection port 5 of an edge. Next, the lower substrate 2 and the upper substrate 3 are introduced at the substrate introduction chamber B, the substrate introduction chamber B is discharged to form vacuum to a pressure of 10^{-3} torr, thereby washing the lower and

upper substrates 2 and 3.

Thereafter, a gate valve 20B between the conveying chamber A and the substrate introduction chamber B is opened, the lower and upper substrates 2 and 3 are moved into the conveying chamber A by means of the elevator 27. A gate valve 20C is opened, the lower substrate 2 is conveyed to a liquid crystal supply chamber C in a state to be discharged to form vacuum to a pressure of 10^{-3} torr by means of a conveying robot 15 positioned at the conveying chamber A. A gate valve 20D is opened, the upper substrate 3 is conveyed to the location set chamber D in a state to be discharged to form vacuum to a pressure of 10^{-3} torr.

The sealing material 4 is loaded on the X-Y movable table 17 in the liquid crystal supply chamber C, the liquid crystal is supplied from a drop supply device 6 of filling 50 through 95 % of required amount of a liquid crystal previously calculated to be supplied in the sealing material 4 of the lower substrate 2 under a pressure reduction of 10^{-3} torr.

At this time, when a plurality of liquid crystals are dropped at the same intervals as shown in FIG. 1(b), a drop may be performed while the X-Y movable table 17 on which the lower substrate 2 is loaded, is operated to horizontally move the lower substrate 2. Further, when a coating operation

as shown in FIG. 1(b) is performed, a bar to which a liquid crystal is adhered contacts with a surface of the lower substrate 2 and is performed by cooperating with the X-Y movable table.

Since the supply of the liquid crystal does not use a conventional capillary phenomenon, it is unnecessary to perform under a pressure reduction. However, it is preferred that the supply of the liquid crystal is performed under the pressure reduction to prevent a penetration of impurity such as dust to the liquid crystal and a component blazing due to gas penetration. After the liquid crystal is supplied under atmosphere pressure, the atmosphere is adjusted to a pressure reduction. However, the liquid crystal may be supplied and dispersed during a discharge by a vacuum pump. Accordingly, it is preferred that the liquid crystal is supplied under a pressure reduction.

In the lower substrate 2 in which the liquid crystal of 50 through 95 % is supplied, gate valves 20C and 20D are opened, and the lower substrate 2 is conveyed to the location set chamber D under a pressure reduction of 10^{-3} torr from the liquid crystal drop chamber C by means of the conveying robot 18, and is loaded on an alignment table 22 in the location set chamber D. Next, the upper substrate D that is previously moved in the location set

chamber D, descends by the elevator 28. The upper substrate 3 is loaded on the lower substrate 2 while an outdoor sensor camera (not shown) checks them so that alignment marks marked in the lower and upper substrates 2 and 3 correspond to each other.

Thereafter, gate valves 20D and 20E are opened, and liquid crystal substrate 1 in which the upper substrate 3 is aligned on the lower substrate 3, is conveyed in to the combination/ultraviolet rays hardening chamber E under a pressure reduction of 10^{-3} torr from the location set chamber D. After the pressure plate 9 is loaded on the liquid crystal substrate 1, while applying a load of 10 kg/m^2 thereto, an outdoor ultraviolet rays lamp 10 irradiates ultraviolet rays through a window 24 installed at a lower portion of the combination/ultraviolet rays hardening chamber E for about 1 minute to harden the sealing material 4 made of a hardening resin.

Then, gate valves 20E and 20F are opened, the liquid crystal substrate 1 that has hardened the sealing material by the irradiation of the ultraviolet rays, is conveyed to the heating chamber F under a pressure reduction of 10^{-3} torr from the combination/ultraviolet rays hardening chamber E. Then the liquid crystal substrate 1 is loaded on the heating pate 12 having the heater 13 therein, and is heated by the heater 13 at 100 to 140 ℃ for about 1 to 3 minutes to complete hardening of the sealing material.

Next, in order to supply a liquid crystal of 5 through 50 % of total required amount, when gate valves 20F and 20C are opened, the liquid crystal substrate 1 for sealing the liquid crystal of 50 through 95 % of total required amount is again conveyed into the liquid crystal chamber C under a pressure reduction of 10^{-3} torr from the heating chamber F by means of the conveying robot 15. In order to fill remaining pore, a liquid crystal supply device 6 supplies a liquid crystal of 5 through 50 % of total required amount to the injection port 5 formed at an edge of the lower substrate 2 of the liquid crystal substrate 1.

The liquid crystal substrate 1 in which a supply of a liquid crystal of 5 through 50 % of total required amount is completed, is conveyed to the substrate introduction chamber B under a pressure reduction of 10^{-3} torr from the liquid crystal supply chamber C by the conveying robot 15. Then, gas is exposed into the substrate introduction chamber B, remaining liquid crystal supplied into the injection port 5 is injected into an inside of the liquid crystal substrate 1. Then, the liquid crystal substrate 1 is drawn from the substrate introduction chamber B and the injection port 5 is sealed, which results in a completion of a filling of the liquid crystal of total required amount.

As described above, according to a liquid crystal filling method of the

present invention, respective procedures from a first liquid crystal supply of 50 through 95 % to a liquid crystal injection of remaining 5 through 50 % can be easily performed by means of a conveying robot. At this time, the liquid crystal filling can be carried out in a clean state without exposing an outdoor atmosphere of a system within a short time. Although operations in all the chambers in FIG. 2 are performed under a pressure reduction, operations other than a supply of remaining liquid crystals into the liquid crystal supply chamber C can be carried out under atmosphere pressure. In the embodiment, respective procedures are performed in individual chambers. However, they can be carried by an in-line type apparatus or can be integrally processed at need.

A glass substrate of 15 inches having a required function layer such as a transparent electrode or an orientation film is filled with a liquid crystal of 350 mg by the conventional injection method as shown in FIG. 3, and by the method of the present invention using the apparatus of FIG. 2. In the conventional injection method, it takes 720 minutes to perform a vacuum/discharge defoamation of the substrate, 5 minutes to perform a contact of the liquid crystal with the substrate (in a vacuous state), and 240 minutes to perform an injection of the liquid crystal due gas leakage. That is, it takes 965 minutes to perform a total procedure. In the method of the

present invention, it takes 1.5 minutes to a drop the liquid crystal of 80% in the liquid crystal supply chamber C, 1 minute to perform a location set of the substrate in the location set chamber D, and 5 minutes to perform an operation in the combination/ultraviolet rays hardening chamber E, 3 minutes to perform a heating harden in the heating chamber F, 0.5 minute to drop remaining liquid crystal of 20 % in the liquid crystal supply chamber C, and 60 minutes to perform an injection of the liquid crystal due to gas leakage in the substrate introduction chamber B. That is, it takes 66.5 minutes to perform a total process. The present invention can perform filling of the liquid crystal with a time of 1/15 in comparison the convention method.

Furthermore, in the embodiment, although the glass substrate is used as the substrate, a plastic substrate can be used. Further, according to the present invention, in order to fill mucoid function material at a shallow pore of several µm in a large flat panel such as an electrochromical display element as well as a liquid crystal display device, the aforementioned efficiently useful injection method can be applicable thereto.

In the embodiment, ultraviolet rays hardening, thermosetting combined resin is used as a sealing material formation resin. However, in order to secure a sealing due to hardening of the sealing material of a

substrate filled with viscous liquid material, it is not limited to the above-mentioned resin according to a kind of the filled viscous liquid material. An ultraviolet rays hardening resin or a thermosetting resin such as epoxy system may be used. Moreover, when the ultraviolet rays hardening resin is used, the process of FIG. 1(e) and the process in the heating chamber F of FIG. 2 can be omitted. Also, when the thermosetting resin is used, the process of FIG. 1(d) and the process in the combination/ultraviolet rays hardening chamber E of FIG. 2 can be omitted.

[Effect of the Invention]

As mentioned above, according to a filling method described in claims 1 and 2 of the present invention, a time of a filling process of viscous liquid material is significantly shortened. First, 50 to 95 % of the required amount of the viscous liquid material at an inside of the substrate enclosed by a sealing material layer, and remaining 5 to 55 % of viscous liquid material is injected into a substrate obtained by combining the lower and upper substrates with each other and hardening them. Through the above-motioned two steps, precise control of supply amount of materials is not required in comparison with a case that a total required amount of materials are dropped and filled once. It is easy to form a gap between the substrates. A contacting

deterioration occurring during a combination of the two substrates can be solved, which allows a substrate having a stable performance to be obtained.

That is, by using advantages of a conventional injecting method and drop method, and eliminating disadvantages thereof, a filling time due to a simple process and operation is significantly reduced, thereby rendering great improvement to a productivity of a large flat panel.

[Description of Drawings]

FIGS. 1(a) through 1(f) are views for illustrating a process sequence in a liquid crystal injecting method according to the present invention.

FIG. 2 is a view for illustrating a liquid crystal injecting method according to an embodiment of the present invention.

FIGS. 3(a) and 3(b) are views for illustrating an example of a conventional liquid crystal injecting method.

[Meaning of numerical symbols in the drawings]

1 : liquid crystal substrate
2 : lower substrate
3 : upper substrate
4 : sealing material
5 : injection port
6 : liquid crystal supply device
7 : liquid crystal
9 : pressure plate
10 : ultraviolet rays lamp
12 : heating plate
13 : heater
15 : conveying robot